

# First Record of *Magelona parochilis* (Annelida: Magelonidae) in South Korea

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## ABSTRACT

The magelonid polychaete *Magelona parochilis* Zhou and Mortimer, 2013 is newly reported from South Korea. The Korean specimens correspond well to the original description of *M. parochilis* in having prostomium without horn, mucronate chaetae on chaetiger 9, superior dorsal lobes on chaetigers 1–8, ventral neuropodial lobes on chaetiger 9, smooth edged thoracic notopodial lamellae, and unidirectional tridentate hooded hooks on abdominal chaetigers. Partial sequences of cytochrome *c* oxidase I (*COI*) and 16S ribosomal DNA (16S rDNA) of the species were determined from Korean specimens. The detailed description and illustrations are provided with partial sequences of *COI* and 16S rDNA as molecular markers for species identification.

**Keywords:** Polychaeta, Magelonidae, morphology, molecular analysis, taxonomy

## INTRODUCTION

Magelonidae Cunningham and Ramage, 1888 is a relatively small family of marine annelids comprising approximately 75 species (Mortimer et al., 2021; WoRMS Editorial Board, 2022). Magelonids are characterized by a shovel-like prostomium, a pair of ventrolaterally inserted papillated palps, and a slender body divided into two distinct regions: thorax and abdomen. Magelonids commonly live in sand and mud less than 100 m deep and some are known to build tubes (Parapar et al., 2021). *Magelona* F. Müller, 1858, the type genus of the family, is characterized by having nine chaetigers in the thoracic region. Until now, 11 species have been reported in East Asia: *M. agoensis* Kitamori, 1967; *M. californica* Hartman, 1944; *M. cf. cincta* Ehlers, 1908; *M. cornuta* Wesenberg-Lund, 1949; *M. crenulifrons* Gallardo, 1968; *M. japonica* Okuda, 1937; *M. koreana* Okuda, 1937 (originally described as a subspecies of *M. japonica*); *M. longicornis* Johnson, 1901; *M. cf. pacifica* Monroe, 1933; *M. parochilis* Zhou and Mortimer, 2013; and *M. pitelkai* Hartman, 1944 (Okuda, 1937; Kitamori, 1967; Paxton and Chou, 2001; Mortimer and Mackie, 2009; Zhou and Mortimer, 2013). *Magelona koreana*, originally described as *Magelona japonica* var. *koreana*, is currently considered as a separate species by the unequal size between noto- and neuropodial postchaetal lamellae on abdo-

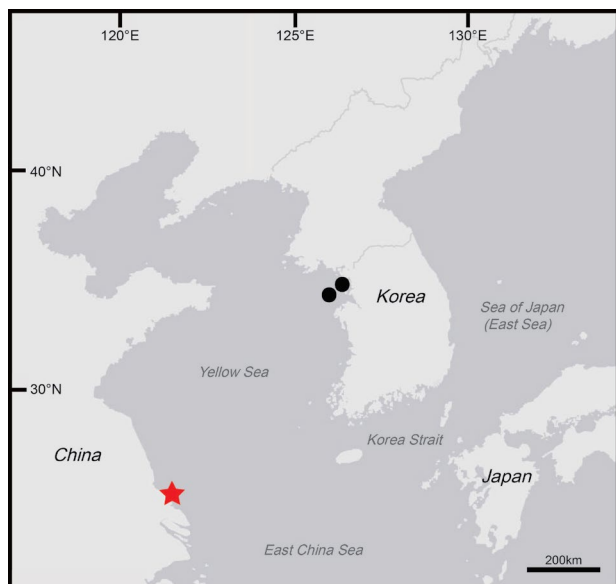
minal chaetigers, the presence of ventral neuropodial lobes on chaetiger 9, and the absence of superior dorsal lobes on abdominal chaetigers (Okuda, 1937; Gallardo, 1968; Jones, 1971). Considering this view, two species, *M. japonica* and *M. koreana*, have been reported from South Korea (Okuda, 1937; Paik, 1975, 1989; Yi et al., 1982). In this study, *Magelona parochilis* is newly found in South Korea and its description, illustrations, and molecular information of partial cytochrome *c* oxidase I (*COI*) and 16S ribosomal DNA (16S rDNA) sequences are provided.

## MATERIALS AND METHODS

Samples were collected using a scoop from silty or muddy sands of Gureop-Island and Eurwangni Beach, Incheon, South Korea (Fig. 1). Specimens were then fixed in 4% formaldehyde for morphological analysis and in 95% alcohol for DNA analysis. All voucher specimens were deposited in the National Institute of Biological Resources at Incheon, South Korea (NIBR). Morphological observations were conducted under a stereoscopic microscope (SZX12; Olympus, Japan), and photographs of the specimens were taken using a digital camera (Dhyana 400DC; Tucsen, China) with the Mosaic capture program (Mosaic version 15; Tucsen). The dissected

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**Fig. 1.** Type locality of *Magelona parochilis* Zhou and Mortimer, 2013 (red star) and sampling sites in this study (black circle).

appendages were observed using an optical microscope (DM 2500; Leica, Germany), and photographs were taken using a digital camera (EOS 6D Mark II; Canon, Japan). Specimens for scanning electron microscopy (SEM) were dried through critical point drying, covered with platinum, and observed using a Hitachi SEM model S-4300SE (Hitachi, Japan). Staining patterns were observed using methyl green, as detailed by Mackie and Gobin (1993). DNA was extracted from the muscular tissues of three alcohol-preserved specimens (NIBR-IV0000899192, NIBR-IV0000899199–200) using LaboPass Tissue Mini (Cosmo GENETECH, Seoul, Korea) according to the manufacturer's instructions. The partial sequences of *COI* and 16S rDNA were amplified using the following primer sets: PolyLCO-F and PolyshortCOIR (Carr et al., 2011) for *COI* and 16Sar-L and 16Sbr-H (Palumbi et al., 1991) for 16S rDNA. The obtained sequences of *COI* and 16S rDNA sequences were edited and aligned using Geneious 8.1.9 (Biomatters, Auckland, New Zealand). Intra- and inter-specific genetic distances were calculated by p-distance, using Geneious 8.1.9. The newly determined DNA sequences were registered in GenBank (OP006721–3 for *COI*, OP021655–7 for 16S rDNA).

## SYSTEMATIC ACCOUNTS

Phylum Annelida Lamarck, 1809

Korean name: <sup>1</sup>\*동근머리양손갯지렁이(신칭)

Class Polychaeta Grube, 1850

Family Magelonidae Cunningham and Ramage, 1888

Genus *Magelona* F. Müller, 1858

<sup>1</sup>\**Magelona parochilis* Zhou and Mortimer, 2013

(Figs. 2–4)

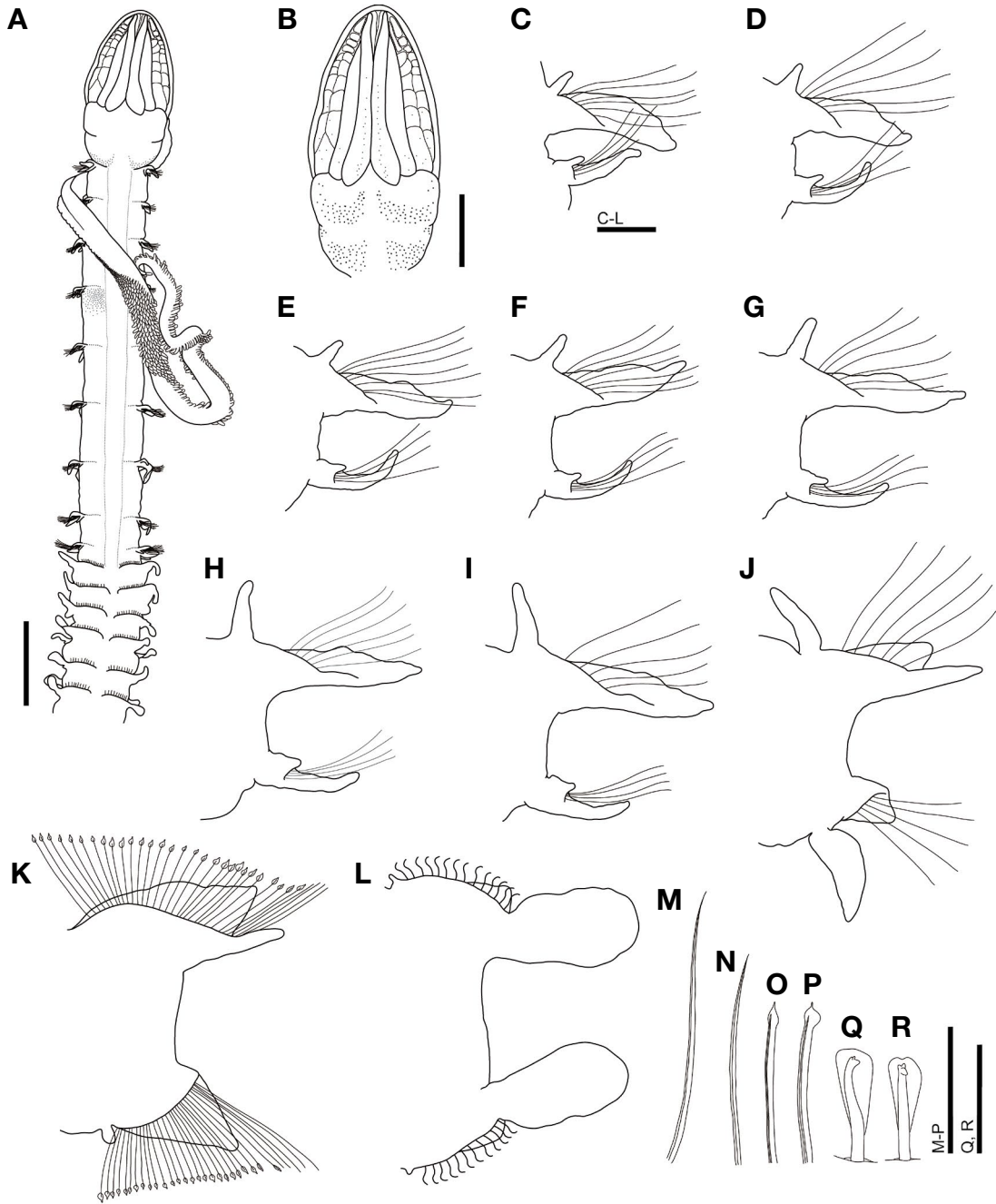
*Magelona parochilis* Zhou and Mortimer, 2013: 1503, figs. 1–5.

**Material examined.** Korea: Incheon: 5 specimens (NIBR-IV0000899192–3, NIBR-IV0000899196, NIBR-IV0000899199–200), Ongjin-gun, Deokjeok-myeon, Gureop-ri, Gureopdo Beach, 37°11'9"N, 125°58'52"E, silty sand, 6 Nov 2021; 30 specimens (NIBR-IV0000899194–5, NIBR-IV0000899197–8), Jung-gu, Eurwangni Beach, 37°26'45"N, 126°22'6"E, muddy sand, 1 Apr 2022; 40 specimens, same locality, 2 May 2022. All examined materials were collected by Lee H-E and Lee GH.

**Description.** A moderately sized specimen, thorax of similar width to abdomen in dorsal view, but abdomen thicker than thorax in lateral view. Longest specimen: complete, prostomium 1.15 mm long, 0.74 mm wide; thorax (including prostomium) 4.22 mm long, 0.56 mm wide; abdomen 0.59 mm wide; total length 27.85 mm long for 64 chaetigers. The broadest specimen: incomplete, prostomium 2.27 mm long, 1.12 mm wide; thorax 6.72 mm long, 0.75 mm wide; abdomen 0.87 mm wide; total length 16.24 mm for 34 chaetigers.

Prostomium elongate, longer than wide (L:W ratio 1.55–2.07), without prostomial horns, anterior margin smooth and rounded, eyes absent (Figs. 2B, 3B, 4A). Two pairs of longitudinal dorsal muscular ridges present on the prostomium; outer and inner pairs abutting each other for entire length; outer pair slightly shorter than inner pair; inner pair diverge only at distal ends (Figs. 2B, 3B, 4A). Indistinct quadrangular areas present on either side of muscular ridges (Figs. 2B, 3B, 4A). Proboscis heart-shaped when fully everted and with longitudinal ridges (Figs. 3D, 4B). Palps arising ventrolaterally from the base of prostomium (Fig. 4B), reaching chaetigers 12–18, non-papillated region reaching chaetigers 1–2. Papillae very short proximally, increasing gradually in size. Initially 3–4 rows of papillae on either side of inconspicuous ventral groove, medially 1–2 rows, and distally 1 row.

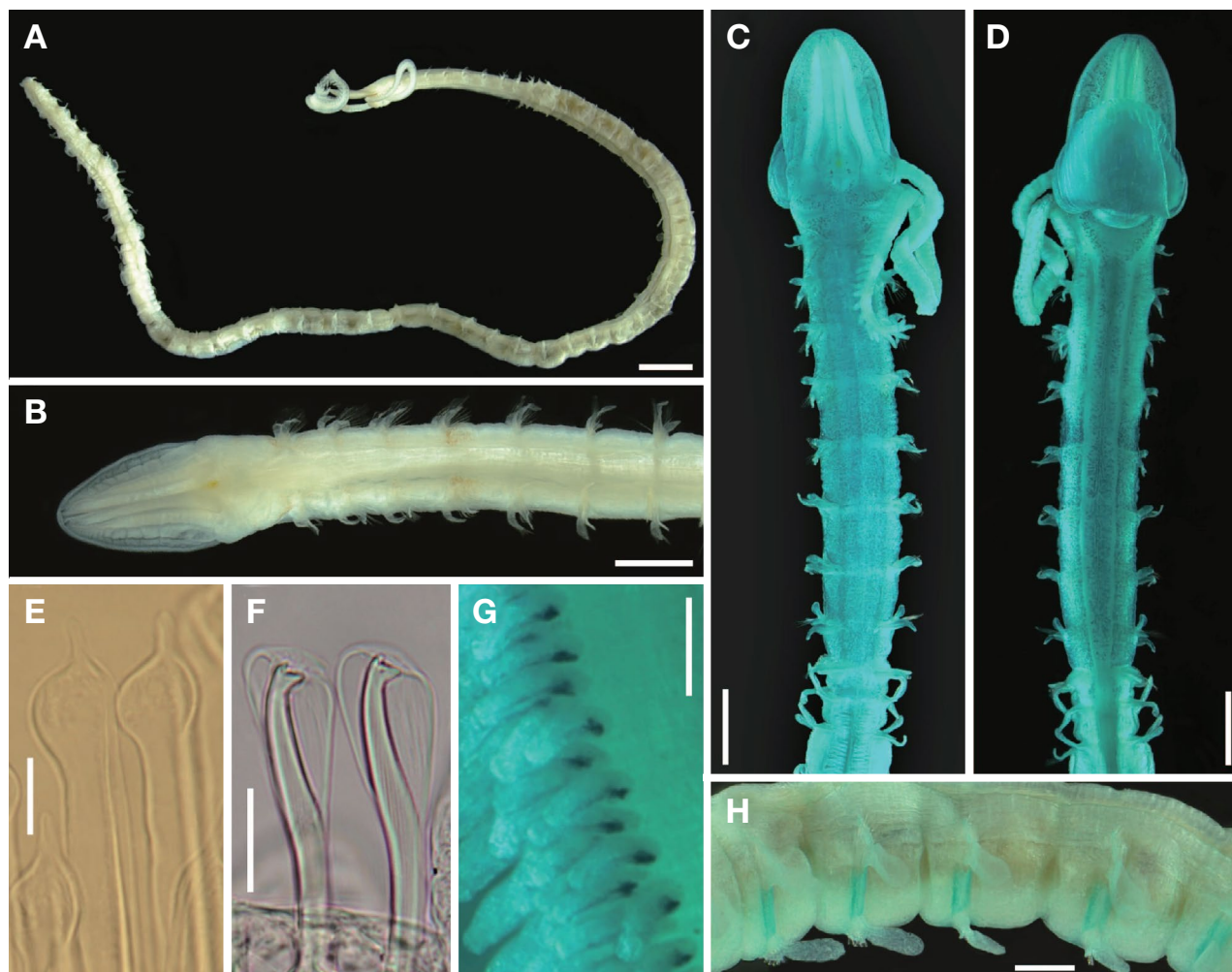
Peristomium achaetous, approximately one and a half times the size of chaetiger 1. Chaetigers 1–7 similar; parapodia biramous. Notopodia with low triangular prechaetal lamellae, slightly increasing in size along thorax, confluent with large spatulate postchaetal lamellae ventrally; point of connection between pre- and postchaetal lamellae becoming closer to distal tips of the lamellae towards the posterior thorax (Fig.



**Fig. 2.** *Magelona parochilis* Zhou and Mortimer, 2013, A (NIBRIV0000899192) B–R (NIBRIV0000899193). A, Anterior region, dorsal view; B, Prostomium, with methyl green staining pattern, dorsal view; C–L, Chaetigers 1–10, anterior view; M, Capillary chaeta from chaetiger 6; N, Outermost capillary chaeta from chaetiger 9; O, Outermost mucronate chaeta from the same chaetiger; P, Mucronate chaeta from the same chaetiger; Q, Tridentate hooded hook from chaetiger 12, anterior view; R, Tridentate hooded hook from chaetiger 10, lateral view. Scale bars: A=1 mm, B=0.5 mm, C–P=0.1 mm, Q, R=50  $\mu$ m.

2C–I). Notopodial postchaetal lamellae becoming longer and thinner distally along thorax; upper edges relatively smooth. Neuropodial pre- and postchaetal lamellae not developed. Slender, tapering digitiform superior dorsal lobes present on

chaetigers 1–8, increasing in size along thorax (Fig. 2C–J). Slender, triangular and subchaetal ventral neuropodial lobes present on chaetigers 1–7, directly underneath chaetae (Fig. 4D).



**Fig. 3.** *Magelona parochilis* Zhou and Mortimer, 2013, A (NIBRIV0000899194), B, F (NIBRIV0000899193), C, D, H (NIBRIV0000899195), E (NIBRIV0000899196), G (NIBRIV0000899192). A, Whole body, lateral view; B, Anterior region, dorsal view; C, Anterior region, dorsal view; D, Anterior region, ventral view; E, Mucronate chaetae from chaetiger 9; F, Tridentate hooded hooks from chaetiger 12, anterior view; G, Papillae of a palp; H, Abdomen, lateral view. Scale bars: A=1 mm, B–D=0.5 mm, E=10  $\mu$ m, F=20  $\mu$ m, G=0.1 mm, H=0.2 mm.

Chaetiger 8 with well-developed notopodial prechaetal lamellae, confluent with slightly larger, rounded triangular postchaetal lamellae; point of connection between pre- and postchaetal lamellae near the distal tip, form a U-shaped structure around chaetae in lateral view (Fig. 2J). Neuropodial prechaetal lamellae of chaetiger 8 low triangular, confluent with postchaetal lamellae. Thick, digitiform ventral neuropodial lobes present. Chaetae of chaetigers 1–8 simple unilimbate winged capillaries (Figs. 2M, 4D).

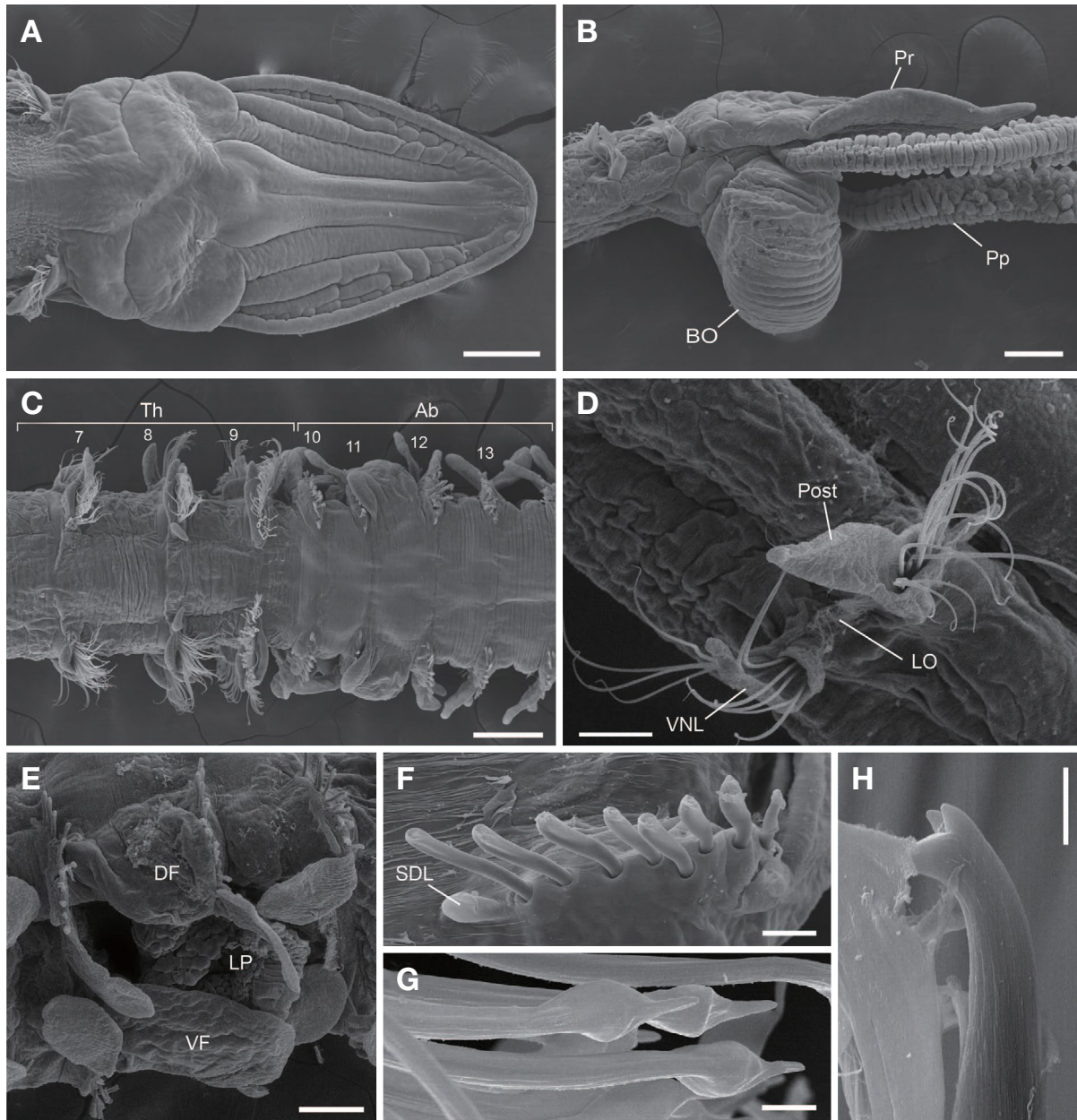
Chaetiger 9 shorter and narrower than preceding chaetigers (Figs. 2A, 3C, 4C). Notopodial prechaetal lamellae rounded, smooth, confluent with higher triangular postchaetal lamellae. superior dorsal lobes absent (Fig. 2K). Neuropodia with triangular postchaetal lamellae confluent with low prechaetal

lamellae. Small ventral neuropodial lobes present. Chaetae mucronate, arranged in arcs; outermost chaetae unilimbate (Figs. 2K, N–P, 3E, 4G).

Abdominal chaetigers with spatulated lateral lamellae, of about equal size in both rami, with bluntly rounded smooth margin (Figs. 2L, 3H). Lateral lamellae not overlapping. Postchaetal extension of lateral lamellae apparent in anterior abdomen. Minute superior dorsal lobes and ventral medial lobes present at inner margin of chaetal rows (Figs. 2L, 4F)

Abdominal chaetae tridentate hooded hooks of similar size, superior two fangs parallel, above main fang (Figs. 2Q, R, 3F, 4F, H). Hooks in each ramus unidirectional, main fangs pointing laterally (Fig. 4F). A few hooks closest to the lamellae slightly twisted in extreme posterior parapodia, appearing *vis-*





**Fig. 4.** Scanning electron microscopy images of *Magelona parochilis* Zhou and Mortimer, 2013, A, C, F-H (NIBRIV0000899197), B (NIBRIV0000899198), D, E (NIBRIV0000899199). A, Prostomium, dorsal view, palps removed; B, Prostomium, lateral view; C, Chaetigers 7-13, dorsal view; D, Parapodia on chaetiger 5, lateral view; E, Lateral pouch between chaetiger 11-12; F, Notopodial chaetae in anterior abdominal region, posterior view; G, Mucronate chaetae on chaetiger 9; H, Tridentate hook in abdomen, hood removed. Ab, abdomen; BO, burrowing organ; DF, dorsal flap; LO, lateral organ; LP, lateral pouch; Post, postchaetal lamella; Pr, prostomium; Pp, palp; SDL, superior dorsal lobe; Th, thorax; VF, ventral flap; VNL, ventral neuropodial lamella. Scale bars: A-C=0.2 mm, D=50  $\mu$ m, E=0.1 mm, F=20  $\mu$ m, G, H=5  $\mu$ m.

*à-vis* orientation. Initially about 11-14 hooks per rami, decreasing to about 7-9 hooks per rami on posterior chaetigers.

Lateral pouches present from between chaetigers 11-12. Paired anteriorly open pouches present between chaetigers 11-12, 14-15, and sometimes additionally between 17-18

( $\Sigma$  configuration pouches of Fiege et al. (2000): well-developed large membrane bounded between two cuticular flaps) (Fig. 4E). Unpaired posteriorly open pouches present in middle and posterior abdomen alternatively (C configuration pouches of Fiege et al. (2000): simple pocket-like pouch with

**Table 1.** Pairwise genetic distances of *COI* and 16S rDNA sequences between *Magelona parochialis* Zhou and Mortimer, 2013 and its congeners

No.	Species	Location	No.										Source	GenBank accession No.	Reference			
			1	2	3	4	5	6	7	8	9	10						
<i>COI</i> (546 bp)																		
1	<i>M. parochialis</i>	Korea														NCBI	OP006721	This study
2		Korea	0.000													NCBI	OP006723	This study
3		Korea	0.004	0.004												NCBI	OP006722	This study
4	<i>M. mackiei</i>	Nigeria	0.185	0.185	0.185											NCBI	MZ334706	Mortimer et al. (2022)
5	<i>M. fasciata</i>	Ghana	0.185	0.185	0.185	0.174										NCBI	MZ334681	Mortimer et al. (2022)
6	<i>M. mirabilis</i>	France	0.185	0.185	0.187	0.209	0.209									NCBI	KT726959	Weigert et al. (2016)
7	<i>M. cincta</i>	India	0.200	0.200	0.200	0.196	0.225	0.216								NCBI	MZ504161	Dias et al. (unpublished)
8	<i>M. crenulifrons</i>	India	0.202	0.202	0.200	0.198	0.216	0.203	0.233							NCBI	MZ504189	Dias et al. (unpublished)
9	<i>M. alleni</i>	UK	0.207	0.207	0.209	0.213	0.211	0.251	0.205	0.218						NCBI	MZ334672	Mortimer et al. (2022)
10	<i>M. picta</i>	Angola	0.209	0.209	0.209	0.180	0.192	0.211	0.218	0.207	0.227					NCBI	MZ334690	Mortimer et al. (2022)
<i>16S rDNA</i> (464 bp)																		
1	<i>M. parochialis</i>	Korea														NCBI	OP021655	This study
2		Korea	0.000													NCBI	OP021656	This study
3		Korea	0.000	0.000												NCBI	OP021657	This study
4	<i>M. mirabilis</i>	France	0.177	0.177	0.177											NCBI	KT726959	Weigert et al. (2016)
5	<i>M. johnstoni</i>	UK	0.193	0.193	0.193	0.211										NCBI	MZ334750	Mortimer et al. (2022)
6	<i>M. mackiei</i>	Nigeria	0.210	0.210	0.210	0.210	0.213									NCBI	MZ334740	Mortimer et al. (2022)
7	<i>M. fasciata</i>	Ghana	0.216	0.216	0.216	0.209	0.238	0.108								NCBI	MZ334737	Mortimer et al. (2022)
8	<i>M. picta</i>	Angola	0.230	0.230	0.230	0.218	0.230	0.188	0.184							NCBI	MZ334752	Mortimer et al. (2022)
9	<i>M. nanseni</i>	Nigeria	0.233	0.233	0.233	0.217	0.235	0.189	0.182	0.078						NCBI	MZ334735	Mortimer et al. (2022)
10	<i>M. guineensis</i>	Nigeria	0.235	0.235	0.235	0.221	0.240	0.184	0.178	0.082	0.038					NCBI	MZ334738	Mortimer et al. (2022)

thin membrane and smooth edge, commonly form lateral bulges). The unpaired posteriorly open pouches of the largest specimen were on chaetigers 26R, 29L, 30R, 33L and those of other specimens also had a similar pattern of pouch locations from about chaetiger 30.

Two anal cirri present on pygidium laterally.

**Color and methyl green staining pattern.** Observations were made on both the alcohol- and formalin-fixed specimens. The preserved specimens were creamish-white in alcohol. Some specimens had light brown speckles at the basal margin of the prostomium and the dorsum behind the notopodia on chaetiger 4 (Figs. 2A, 3B). Specimens stained with methyl green showed distinct patterns on the prostomium and thorax. Small speckles were present on the inner prostomial ridges longitudinally, and large dark speckles were present in the achaetous region (Figs. 2B, 3C). Each papilla of the palps had a weak longitudinal stain along the papilla and the stain became dark and oval-shape at the base (Fig. 3G). Speckles were scattered in the thoracic region, strongest on chaetiger 4, and the area surrounding parapodia was less stained (Fig. 3C, D). Weak interparapodial staining was present in the abdomen. Two parallel green lines were present between the notopodial and neuropodial lamellae in the abdomen (Fig. 3H).

**Distribution.** China (type locality, Zhou and Mortimer, 2013) and Korea (present study).

**Molecular information.** Partial *COI* and 16S rDNA sequences of the Korean *Magelona parochilis* specimens were obtained in this study. The intra-specific genetic distances were 0.0–0.4% in *COI* (546 bp) and no variation was found in 16S rDNA (464 bp) (Table 1). In comparison with congeners, the inter-specific genetic distances ranged from 18.5% to 20.9% for *COI* and from 17.7% to 23.5% for 16S rDNA (Table 1).

**Remarks.** The morphological characteristics of Korean specimens corresponded to the original description of *M. parochilis* by Zhou and Mortimer (2013): (1) mucronate chaetae present on chaetiger 9, (2) the presence of superior dorsal lobes on chaetigers 1–8 and ventral neuropodial lobes on chaetiger 9, (3) smooth edged thoracic notopodial lamellae, and (4) unidirectional tridentate hooded hooks on abdominal chaetigers. In Korean specimens, superior dorsal lobes and ventral medial lobes are clearly observed although Zhou and Mortimer (2013) described *M. parochilis* as not having superior dorsal lobes and ventral medial lobes on abdominal chaetigers (Zhou and Mortimer, 2013). However, the scanning electron microscopy image of chaetiger 42 of paratype in Zhou and Mortimer (2013) showed *M. parochilis* has minute lobes at the inner margin of chaetal rows (see fig. 4E in Zhou and Mortimer, 2013). Distinct methyl green staining patterns in the prostomium and achaetous regions described in the original description were also observed in the Korean speci-

mens. Therefore, the Korean specimens collected in this study were identified as *M. parochilis*.

*Magelona* species with rounded prostomium lacking frontal horns and mucronate chaetae on chaetiger 9 belong to the ‘*Magelona mirabilis* group’ (Zhou and Mortimer, 2013; Mortimer et al., 2021). Among them, the Korean specimens are most similar to *M. brachypalpata* Mortimer, Blake and Harrendence, 2021 from Northeast America and *M. riojai* Jones, 1963 from the Gulf of Mexico in having superior dorsal lobes on chaetigers 1–8, smooth edged thoracic lamellae, and unidirectional tridentate hooded hooks in the abdomen (Jones, 1963; Mortimer et al., 2021). However, the Korean specimens differ from the latter species in the presence of ventral neuropodial lobes in neuropodia on chaetiger 9 (Jones, 1963; Mortimer et al., 2021). Among the species described from the Western Pacific, the Korean specimens most closely resemble *Magelona tinae* Nateewathana and Hylleberg, 1991 from Thailand in having superior dorsal lobes on chaetigers 1–8 and ventral neuropodial lobes on chaetiger 9 (Nateewathana and Hylleberg, 1991). However, Korean specimens differ from the latter species in the shape of thoracic notopodial lamellae. Korean specimens have smooth edged thoracic lamellae, whereas the latter species has distinctly bilobed lateral lamellae on chaetiger 8 (Nateewathana and Hylleberg, 1991). The Korean specimens were distinctly different from the two species, *M. japonica* and *M. koreana*, previously reported in South Korea, by the prostomium lacking frontal horns and the presence of mucronate chaetae on chaetiger 9 (Okuda, 1937).

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## CONFLICTS OF INTEREST

Gi-Sik Min, a contributing editor of the *Animal Systematics, Evolution and Diversity*, was not involved in the editorial evaluation or decision to publish this article. All remaining authors have declared no conflicts of interest.

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